WHAT IS CLAIMED IS:

1. A plasma reactor for conversion of light hydrocarbons to hydrogen-rich gas, comprising:
   a wall defining a reaction chamber;
   an outlet;
   a reagent inlet fluidly connected to the reaction chamber for creating a vortex flow in said reaction chamber;
   a first electrode; and
   a second electrode connected to a power source for generation of a sliding arc discharge in the reaction chamber.

2. The plasma reactor of claim 1, wherein the reaction chamber is substantially cylindrical.

3. The plasma reactor of claim 1, wherein said vortex flow is a reverse vortex flow.

4. The plasma reactor of claim 3, wherein said reagent inlet for creating said reverse vortex flow comprises a gas supply and one or more gas inlet nozzles oriented tangentially relative to the wall of the plasma reactor.

5. The plasma reactor of claim 4, wherein said reactor comprises first and second ends, the reagent inlet is located proximate to the first end, and the reactor further comprises a second inlet fluidly connected to the second end of said reactor.

6. The plasma reactor of claim 5, wherein the second electrode is positioned a substantially constant distance from the first electrode during operation of the reactor.

7. The plasma reactor of claim 6, wherein the first electrode is positioned proximate to the first end the reactor and at least a portion of the second electrode is positioned in the reaction chamber to create a gap between the anode and the cathode for initiation of a plasma generating electrical arc at said gap.

8. A plasma reactor as claimed in claim 7, wherein the first electrode also functions as a flow restrictor to assist in the generation of a reverse vortex flow.

9. A plasma reactor as claimed in claim 8, wherein the second electrode is a spiral shaped electrode.

10. A plasma reactor as claimed in claim 9, wherein a distal end of the spiral shaped electrode, relative to the position of the first electrode, terminates in a circular ring shape.

11. A plasma reactor as claimed in claim 8, wherein the second electrode is a combination of a spiral shaped electrode and a circular ring electrode.

12. A plasma reactor as claimed in claim 6, wherein the second electrode is a movable electrode which can be positioned in a first position to create a gap between the second electrode and the first electrode for electric arc ignition, and in a second position, after electric arc ignition, at a greater distance from said first electrode to provide a stable plasma in said reaction chamber.

13. A plasma reactor as claimed in claim 1, further comprising at least one heat exchanger for preheating at least one reagent for feeding to said plasma reactor by heat exchange with at least one product from said plasma reactor.

14. A method for converting light hydrocarbons to a hydrogen-rich gas comprising the steps of:

providing a plasma reactor, said plasma reactor comprising:

a wall defining a reaction chamber;

an outlet;

a reagent inlet fluidly connected to the reaction chamber for creating a vortex flow in said reaction chamber;

a first electrode; and

a second electrode connected to a power source for generation of a sliding arc discharge in the reaction chamber;

introducing a gas selected from the group consisting of one or more light hydrocarbons, oxygen, an oxygen containing gas, and mixtures thereof, into said reaction chamber in a manner which creates a vortex flow in the reaction chamber;

processing said light hydrocarbons using a plasma assisted flame; and

recovering hydrogen-rich gas from said reactor.

15. The plasma reactor of claim 14, wherein said vortex flow is a reverse vortex flow.

16. The method of claim 15, wherein said reverse vortex flow is created by feeding a gas containing light hydrocarbons into said reaction chamber in a direction tangential to the wall of said reaction chamber.

17. The method of claim 15, wherein said reverse vortex flow is created by feeding an oxygen-rich gas into said reaction chamber in a direction tangential to the wall of said reaction chamber.

18. The method of claim 17, wherein said plasma reactor comprises first and second ends, the reagent inlet is located proximate to the first end, the reactor further comprises a second inlet fluidly connected to the second end of said reactor, and wherein at least some of said gas selected from the group consisting of one or more light hydrocarbons, oxygen, an oxygen containing gas, and mixtures thereof, is provided to the reaction chamber via the second inlet.

19. The method of claim 18, wherein the plasma reactor comprises a movable second electrode and said method further comprises the steps of igniting an electrical arc with said movable second electrode in a first position, and moving the movable second electrode to a second position farther from said first electrode than said first position for operation of said reactor.